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THE INFLUENCE OF A COMPETITIVE SEASON OF ICE HOCKEY ON EIGHT YEAR OLD BOYS

by

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "The Influence of a Competitive Season of Ice Hockey on Eight Year Old Boys" submitted by Guy Thibault in partial fulfilment of the requirements for the degree of Master of Arts.

ABSTRACT

Changes in the ability and the physical work capacity of eight year old boys after a competitive four month hockey season were measured and compared with a control group of children of the same age who were not playing hockey. The tests used were the PWC_{170} on a bicycle ergometer, static measures of muscular strength, a series of anthropometric measures, as well as the CAHPER Fitness Performance Test Items. In addition, the hockey group was given certain skating and hockey ability tests.

Among the anthropometric measures, a statistically significant increase between pre and post season results was found for the following items: height, weight, and bi-acromial width. There was also a significant difference for PWC_{170} and PWC_{170}/Kg of body weight between the pre and post tests as well as between the two groups. Concerning the tests of fitness performance, the two groups were found to be significantly different for all items and in the case of four a significant pre-post result was obtained. In the hockey tests there was a significant difference between the pre and post season values in forward skating (90 feet), in agility skating, and in the puck control test.

It was concluded that the hockey group improved their endurance fitness (as measured by the PWC_{170} test) significantly more than the control group. The data also suggest that the hockey group

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was superior to the control group, on most fitness-performance items, before the season began. The effect of the hockey season on these items was less dramatic however. The strength items did not appear to be influenced by the season of play.

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CHAPTER I

INTRODUCTION

Hockey is an international game, at least for the countries of the Northern Hemisphere. It is a game played by adults and children, old and young, professional and amateur all over our country. The game of hockey is growing in popularity certainly because of the extensive television coverage of professional leagues in America, olympic tournaments and international games. One important factor of this growth is the increasing participation of children in the game of hockey under a wide range of different programs. Most of these programs are either competition oriented, with scheduled league games or tournament games, or less organized with informal games or exhibition matches between communities, towns or villages.

There is limited literature on hockey skills and techniques for all levels of players, with some chapters or paragraphs referring to the physical conditioning necessary to play the game with efficiency and lack of fatigue (21, 34, 35, 39, 43, 45, 47). There have been very few studies, up until now, on the physical fitness of hockey players, specially on young hockey players of eight years of age. A study by Doroschuk and Marcotte (18) looked at the construction of a test for screening ice hockey players of all age levels, while another study by Merrifield and Walford (36) was concerned with the items to include in a skill test for ice hockey. In 1971, the same authors (37)

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used this hockey skill test with eight to eleven year old children to evaluate their skill level and form age brackets. Other studies have been conducted on hockey skills (4, 23, 30, 44), but as yet, no studies have been done on children, using an intensive four month hockey season as a training method to improve their physical fitness.

It is well known amongst exercise physiologists that the best single measure of fitness is the maximum oxygen uptake, but it is not always possible to use well equipped laboratories to measure this parameter. There is no one test of fitness since it is a state which characterizes the degree to which the organism is able to function. It can be measured by aerobic capacity, strength and a few more performance items such as runs and jumps (13). Many studies done on children looked only at their physical working capacities in relation to sex and age (1, 2, 3, 6, 8, 9, 10, 12, 14, 26, 27, 41), as others measured their maximum oxygen uptake and cardiac output (5, 6, 7, 8, 15, 16, 17, 19, 20, 22, 28, 29, 33, 42, 46). In a recent commentary, Macnab (32) made this statement:

> Aerobic capacity also fails to take into account other factors involved in performance of physical work (e.g. specificity of task, motivation, strength, anaerobic capacity). The item which best correlates with the time required to run two miles is the time required to run two miles. Thus in predicting performance, aerobic capacity, at best, only imitates specific tests.
>
> Variance characteristics of the sample and the relative contribution of aerobic capacity to a given type of performance should thus be seriously considered in any studies of the relationship of aerobic capacity to external criteria of performance.

Following this line of thinking, this study of young hockey players took into account these other factors involved in performing physical work; specificity of task with a hockey skill tests; strength with measurements on that parameter; other items such as physical working capacity; performance on different items and anthropometric data. It is hoped that the measurement of fitness of these children, in a very practical study, will incite others to look closely at the fitness of young children and to find ways of improving that parameter since physically fit youth is a good base on which to build a strong and healthy population. It is also hoped that this study will fill a lack of pertinent information concerning the fitness of children who enjoy their most liked sport as a means of training.

STATEMENT OF THE PROBLEM

The present study involved two groups of children eight years of age. One group consisted of 14 hockey players participating in an organized competition oriented league. The other group was comprised of 14 non-hockey players who participated in other sports or physical activities.

Specifically, the study focused upon the following variables:

1. Physical work capacity as measured by the PWC_{170} bicycle ergometer test (26)
2. Physical fitness as determined by:
   a) a fitness-performance test (24)

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- the 50 yard run
- the 300 yard run
- the shuttle run
- the one-minute speed sit-up
- the standing broad jump
- the flexed arm hang

b) strength measurements (27)
- grip strength (both hands)
- elbow flexion and extension and knee extension (left side only) on the Hettinger chair

3. Anthropometric measures:
- body weight
- body height
- bi-acromial measures
- bi-illiac measures

4. And for the hockey group:
- specific abilities concerning hockey as measured by the Hockey Canada Skill Test (23).

JUSTIFICATION OF THE STUDY

The improvement of the physical fitness of children should be one of the main objectives in any physical education program, both in the schools and in the communities. Many studies have been conducted on the physical fitness of adults, males and females, on training methods and intensities of work necessary to bring normal healthy

people to an above average physical condition and fitness.

This study was designed to look at the influence of an intensive four month hockey season on the fitness of a group of young children eight years of age. Their initial level of fitness was measured at pre-season in comparison with the fitness of a control group of non-hockey players. A PWC_{170} exercise test was performed to measure their work capacity, a fitness test was administered to analyse their general physical condition, and strength measures were taken. To the hockey group, a hockey skill test was given to assess their proficiency and their ability in that specific discipline. Practical studies with children are needed in all sports to know if a specific activity in which a child engages, improves his physical fitness and also to determine the intensity to which this specific activity must be engaged in. Playing hockey, for a child, is certainly enjoyable and can be taken as a good training method that can bring beneficial physiological fitness to children of this age group.

LIMITATIONS OF THE STUDY

The selection of the control group presents a possible limitation to the study. The children of the control group may be different from those who participate in hockey, in that they play other sports and may not have the same motivation. The fourteen children in the control group were chosen from the very limited number of non-hockey playing children in the district.

DELIMITATIONS OF THE STUDY

All subjects (twenty-eight) were volunteers from the Malmo and Michener Park communities, in Edmonton. These children come from middle-class families in this district. From the hockey group, many players attended hockey school during summertime and received pre-season training. They are the best team of fourteen players from a group of thirty-four eight year olds from the same community, thus they represent a small portion of the hockey population.

DEFINITION OF TERMS

Anova: analysis of variance.

Competitive program: a program involving well organized competition among other teams in the same age group.

Kilopond: one kp is the force acting on a mass of one kilogram at the normal acceleration of gravity.

Kilopond meter: physical work unit done on a bicycle ergometer during a specific period of time. It is the product of the tension in kiloponds applied against the bicycle wheel and the distance covered by the wheel during one complete revolution of pedals multiplied by the number of revolutions per minute. Expressed in meters kilopond per minute (Kpm/min).

Non-participant: young boys that are sport active outside of a hockey program.

Participant: young boys participating in a community organized hockey program.

Physical fitness: for this study, fitness is the physical powers and endurance of the organism. These qualities are the result of the physical activities and the practices in daily living (31).

PWC_{170}: a test on a bicycle ergometer designed to measure the ability of an individual to perform prolonged physical work with a steady state heart rate of 170.

Work load: work performed against a fixed resistance and measured in kilopond meters per minute (Kpm/min).

CHAPTER II

REVIEW OF LITERATURE

THE PHYSICAL WORKING CAPACITY OF CHILDREN

While participating in competitive sports, children will very seldom reach exhaustion. They will become tired, rest for a short time and then keep on playing for hours and hours. They are active and like to be that way. It is then very difficult to enroll them in hard regimented training regime where every session is planned ahead, well organized and timed, and very often too arduous and boring. Having them training while playing their favourite game is easier and enhance their participation. But of course, to measure their fitness or their performance, a reliable method must be used. One that has been employed very extensively is the measure of the physical working capacity by the mean of the bicycle ergometer test.

In their study of California School children, Adams _et al._ (1) determined the physical working capacity for two hundred and forty-three children of both sexes, ranging in age from 6 to 14 years. Working capacity correlated well with the surface area, height, weight, 3 second vital capacity, total vital capacity and age. The 1 second vital capacity and the blood pressures gave relatively poor correlations. The surface area was selected as the variable to be compared with working capacity. Regression lines and 95% confidence bands were determined for each of the sexes. Boys possessed significantly greater working capa-

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cities than girls, even at the smaller surface area. Differences became quite marked in the older and larger boys as contrasted with girls of the same age or size. The results for eight year old boys with mean values of 131 cm on height and 30 Kg on weight for a mean surface area of 1.06 M^2, gave 438 Kg M/min as a working capacity mean. For the girls at the same age, the mean height was 132 cm, mean weight 30 Kg, mean surface area 1.06 M^2, the working capacity was 343 Kg M/min. The boys had a much higher result.

The same author (2) studied the physical working capacity of one hundred and ninety-six normal Swedish country and city school children of both sexes and of ages 10, 11 and 12 years. Ninety-four of the children were from two country schools, and one hundred and two were from a Stockholm city school. The working capacity was found to increase with age, height, weight, surface area, heart volume and degree of physical training. Of the variables tested, the working capacity had the highest correlation with the heart volume for the city and country boys and for the city girls. For the country girls, the best correlation of the working capacity was with body size, surface area, height and weight. A comparison of the working capacity with the degree of physical training, by sex, of the city and country school children showed that, in the case of both boys and girls from both city and country, the working capacity was significantly greater with increasing degree of physical training. The lowest physical working capacity occurred in city girls who were poorly trained (339 Kg M/min). The highest working capacity was found in a group of highly trained country girls (749 Kg M/min). In comparing the working

capacity between corresponding groups of training, country and city, the only significant differences ($P < 0.002$) were between the highly trained country girls (749 Kg M/min) and the highly trained city girls (484 Kg M/min) .

Alderman (3), in a Canadian study, used the Sjöstrand bicycle ergometer work capacity test on two different occasions, one year apart to measure ninety-nine 10 and 14 year old boys and girls. The Elema-Schönander constant work load bicycle ergometer was used as the testing instrument. PWC_{170} was calculated in the usual fashion, i.e., by extrapolating, on the basis of three 4 minute periods of exercise, to the estimated workload at a heart rate level of 170 beats per minute. All four groups improved in PWC_{170} to a statistically significant degree over the one year interval with the boys of 10 year old increasing from a mean of 797.6 to a mean of 948.2. The girls also showed an increase in their Kpm/min from a mean of 287.4 to 422.6 for the 10 year olds and from a mean of 487.1 to 592.7 for the 14 year olds. Age differences within sexes and sex differences within age levels in PWC_{170} are generally what one would expect, i.e., boys are superior to girls, and the older age groups are superior to the younger age groups. Sex differences between different age brackets are another matter of course. Older girls did have larger PWC_{170} scores than younger boys.

In a Winnipeg study, Cumming and Cumming (14) tested one hundred and twelve children, five male and five female in each age level from 6 to 16 years from ten schools in the city of Winnipeg on a bicycle

ergometer designed by Holmgren and Mattsson, with an electronic brake. The subjects pedalled at a rate of 60 to 70 revolutions per minute and the work was maintained for 18 minutes, the load being increased at 6 and 12 minutes of exercise. For forty subjects, four consecutive 6 minute periods were used instead of three. An attempt was made to make the work load for the final 6 minute period just about the maximum that the subject could comfortably maintain. In all subjects a pulse rate of over 170 per minute was reached. For the age group of eight year old with five subjects, a mean height of 132 cm, a mean weight of 30 Kg and surface area of 1.05 M^2 gave a mean working capacity of 457 Kg/M/min. They also recorded a gradual rise in maximum working capacity with increasing age. The working capacity for the boys was consistently greater than that for the girls. This was true even for the youngest age group of 6 year olds. One exception occurred with the eleven year olds, in this study, having the girls record a mean working capacity of 497 Kg/M/min and the boys a mean of 474 Kg/M/min. A subsequent study of larger numbers of eleven year old children showed that the boys had working capacities 20% greater than the girls. There was a high correlation of the working capacities of the boys with their height (0.865), weight (0.897) and surface area (0.904).

Baggley and Cumming (8) performed a study of physical working capacity and aerobic power on a group of grade 5 and 6 students of Winnipeg. Two measurements were used to assess fitness, the PWC_{170} on the bicycle ergometer by intrapolation or extrapolation from two steady state 6 minute submaximal work loads designed to produce pulse rates of

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130-140 and 160-180 bests per minute. The other measures were obtained when the subjects were asked to continue pedalling at a supermaximal work load designed so that the subject could not sustain the added resistance for more than three minutes. Expired air was collected during the third minute of this exercise and immediately analyzed for oxygen and CO_2. Volume was measured with a calibrated dry gas meter.

Two studies on each child, one week apart were obtained early in September to assess the reliability of the test methods. These boys and girls, mean age in September of eleven, were exercised twice in September, and in December, February, April and June. The mean PWC_{170} values increased as the school year progressed although, because of a wide variability, the change did not reach statistical significance. A decrease was observed for the testing done in April and June. The mean values of the PWC_{170} in Kpm/min for the grade 5 and 6 boys were as follows: 569 in September, 598 in December, 645 in February, 609 in April and 641 in June. The mean values per Kpm/Kg/min followed the same pattern: 15.8 in September, 15.6 in December, 16.4 in February, 15.3 in April and 15.9 in June. The VO_2 max values did increase regularly through the year.

The largest study on this subject was made by CAHPER under the direction of Howell and Macnab (26) in the spring of 1965. They studied a random sample of two thousand one hundred and seven children from schools across Canada, from the age of 7 to 17 years. They used a modified bicycle ergometer, manufactured by the Monark Company, and the Sjöstrand test was performed by the subjects at three increasing work

level, four minutes each, to elicit increasing desired heart rate up to a steady state heart rate of 170 beats per minute in the last four minutes. Subjects pedalled at 60 Rpm. For the eight year old group, boys had a mean body weight of 27.66 Kg to the girls 27.22 Kg. The boys mean PWC_{170} Kpm/M was 351.0 compared to the girls who had a 285.0. Per Kg of body weight, the boys mean value was 12.71 and the girls 10.67. It is easy to see that the boys mean values were higher than the girls, both in Kpm/min and Kg per body weight. The complete data recorded showed that the physical working capacity increased with age, more rapidly for boys than girls. For the girls, there seems to be a plateau after thirteen years of age and a very slight increase from thirteen to seventeen years. The data permitted the preparation of percentile tables that became Canadian standards and are used, with the CAHPER performance test, as a measure for the fitness of Canadian Youth.

All of these studies represent only measurements of children's fitness through measures of their physical working capacity. Most of these studies were performed in Canada and give us nearly the same conclusions, that the physical working capacity of children increases with age and is higher in boys than in girls. But these studies are purely measures taken on one or two occasions or more during a school year or at a certain time. There has been no mention of training of any kind in any of these studies. The young hockey players involved in this study had an intensive season of competition in ice hockey

outside of their regular activities. Playing hockey very competitively is, here, considered as a training factor that could influence their working capacity, outside of the normal growth. Any increase in their PWC may be related to the intensity, frequency and duration of the training and also to the age of the subjects and their initial fitness level. Although very few studies have been made on the effect of training on young children under ten years of age, it is necessary to look at studies performed on older children. It should be noted that most of these contain measures of maximum oxygen uptakes without noting the results on the physical working capacity, and some have been performed on a treadmill.

Vrijens (42) compared eleven volunteer adolescents (mean age 16.7 years) with nine students (mean age 17.1 years) in a scheduled physical education class. The two groups were considered to be equivalent in anthropometrical and functional tests. The experimental group participated in a circuit training (ten exercises) regimen in addition to the regular physical education program for a period of six weeks, with three training sessions per week. The circuit was performed according to the interval principle. The intensity of each exercise (bench-stepping, pull-up, sit up, rope climb, etc.) was fixed at 90% of the individual's performance capacity. After the six weeks of training, the maximum oxygen consumption increased 14% (from 3.1 to 3.6 litres/min), the maximum work loads increased from 283 to 300 watts (1730 to 1834 Kpm/m), the maximum ventilatory volume improved from 98.6 to 111.6 litres/min

(13 %) and finally the improvement of the oxygen pulse was 1.9 ml/beat (from 16.2 5o 18.1 ml/beat). The control group showed no significant gain in any of these tests.

Six boys, all eleven years old were trained by Ekblom (19) over a period of six months and compared to a control group. The training program consisted of interval and distance running, strength training by circuit and weight lifting, ball games and ice hockey, twice a week with each session lasting from 45 to 60 minutes. Before the special training started there were no significant differences between the training and reference groups with regard to body height, body weight, vital capacity and maximal oxygen uptake. All subjects were given periodic laboratory tests at the beginning of the investigation, after six months and for a special group, after 32 months of training. The tests were performed on a bicycle ergometer at two submaximal workloads of 300 and 450 Kpm/min for 6 minutes per workload. After at least 15 minutes of rest, exhaustive exercise was performed for 3-5 minutes on a motor-driven treadmill. The MVO_2 of the training group improved from 2.15 to 2.45 litres/min (15%) or from 53.9 to 59.4 ml/Kg/min, but was unchanged in the control group. The maximum ventilatory volume increased from 68 to 80.4 litres/min (32%) and the maximum heart rate decreased from 204 to 199 beats/min after the training program. At a given submaximal work rate, the heart rate decreased from 148 to 139 beats/min. Five boys from the training group continued training for a further twenty-six months, and it was then found that MVO_2 increased in total

by 55% (from 2.15 to 3.41 litres/min) which was more than expected from the age-dependent increase in terms of body weight.

Daniels and Oldrige (17) tested fourteen boys, aged 10-15, on five occasions during 22 months of distance-running training. Semi-annually, height and weight were recorded as were performances for 1 and 2 mile races. At the start of the program and approximately every six months for the next two years, the subjects participated in a submaximal and maximal treadmill running test. It was, of course, impossible to measure their physical working capacity. After 22 months, average growth was 11.2 cm and 9.2 Kg. Max VO_2 increased from 2331 ml to 2839 ml; max VO_2/Kg did not change significantly from a mean of 59.5 ml/Kg per minute. During the twelve month period of greatest growth (6.4 cm and 5.9 Kg), max VO_2 increased 295 ml, a 50 ml increase per Kg increase in weight. Again no change was measured in max VO_2/Kg. Average improvement in running performance was 32 seconds in the mile and 63 seconds in 2 miles. Steady-state VO_2 (ml/Kg per minute) during submaximal running diminished from 52.0 in the initial test series to 45.5, twenty-two months later. This apparent improvement in running efficiency, which was to a great degree a function of growth, was believed to be mainly responsible for better running performance. To evaluate any training effects from this study is practically impossible because no control group was used and therefore the results confused growth and training effects. The intensity of training was not controlled.

In Cumming's et al. study (15), the physical working capacity and maximum oxygen uptake of fourteen boys and fifteen girls, twelve to eighteen years of age, were measured on an electronically braked Elema bicycle , pedalled at 60-70 r.p.m. on day 1 and day 6 of a track camp where intensive physical training was carried out. The camp program was physically demanding, and, in the course of a day, both boys and girls ran a total distance of 25-40 miles. Mean VO_2 max and PWC_{170} values were compared using the paired data "t" test and significant increase in PWC_{170} occurred in the boys ($p \leq .01$) from 960 Kpm/min on day 1 to 1082 Kpm/min on day 6. For the girls ($p \leq .05$) the increase was from 720 Kpm/min to 795 Kpm/min from day 1 to day 6. As for as VO_2 max is concerned, no significant changes occurred for either group, with the boys very slightly increasing from 3.92 to 4.02 l/min and the girls keeping a 2.76 and 2.75 l/min level. Significant changes in heart volume, stroke volume, total body hemoglobin, lung capacities, or muscle mass, are unlikely to occur with a week of intensive training in already fit young subjects. It is of note that the pulse rates for the submaximal loads declined after one week training, hence the increase in PWC_{170}.

In a study by Wells et al. (46) the physical working capacities (PWC_{170}) and maximal oxygen uptakes (max VO_2) of three groups of teen-aged athletes from Nova Scotia, Canada, were assessed. The Sjöstrand test was administered with slight modifications. Two bouts of work were performed for six minutes each on a Monark bicycle ergometer at the

pedalling rate of 50 pedal revolutions per minute. The work loads were selected to elicit a heart rate of approximately 120 to 160 beats respectively. A third work load was completed if a subject's heart rate remained below 140 on the second work load. Aerobic capacities ranging from 46 to 57 ml/Kg min were observed for twelve girls age twelve to eighteen years while values obtained for nine boys age fifteen to twenty years ranged from 50 to 74 ml /Kg min. PWC and max VO_2 values were evaluated in terms of body weight, fat-free body weight and body surface area. The boys had these mean results: 1149 Kpm/min, 17.06 by Kg of body weight, 21.06 by free fat body weight and 625.11 by surface area in M^2. The girls, a bit younger, had these mean results: 764 Kpm/min, 16.16 by Kg of body weight, 20.30 by free fat body weight and 525.51 by surface area in M^2. These values are all taken on the PWC_{170}. Apparent sexual differences in PWC_{170} performance disappeared when values were expressed in terms of body weight or fat-free body weight. Differences in aerobic capacity remained significant when this procedure was repeated for max VO_2 values. Correlations and regression equations for predicted and obtained max VO_2 values indicated that there is little validity in estimating maximal aerobic capacity for treadmill running from submaximal bicycle ergometer work.

Massicotte (33) performed a study, in Edmonton, on thirty-six students of the Collège St-Jean, aged eleven to thirteen, to determine the relative effects of three intensities of training upon the cardio-respiratory fitness of children when the groups were equated on their

initial fitness level, as well as the duration and frequency of the training sessions. They were tested on a bicycle ergometer prior to and following a six week training program. The subjects were ranked according to MVO_2 relative to body weight and then blocked into three fitness levels. The subjects from each fitness level were then randomly assigned to one of four treatment groups. The first group (T1) trained at a heart rate of 170-180 beats per minute and increased their work load from 600 Kpm/min in week 1, to 950 Kpm/min in week 6. The second group (T2) trained at a heart rate of 150-160 beats per minute and increased their work load from 400 Kpm/min in week 1 to 700 Kpm/min in week 6. The third group (T3) trained at a heart rate of 130-140 beats per minute and they increased their work load from 250 Kpm/min to 525 Kpm/min. The fourth group (T4) was the control group. The training was conducted on a bicycle ergometer three times a week, twelve minutes per session. Heart rates were monitored once a week during the twelve minutes to permit an adjustment of the work load required to elicit the pre-determined heart rates.

Following training, significant decreases in heart rate occurred for the three training groups over the control group at submaximal work load. T1 heart rate decreased from 150 beats per minute to 133 beats per minute after six weeks of training, T2 heart rate decreased from 165 beats per minute to 150 beats per minute and T3 heart rate decreased from 168 beats per minute to 155 beats per minute. The heart rate of the control group T4 increased slightly. There was no significant

difference, however, between the three training groups. Blood lactate concentration decreased in the T1 group at submaximal work load. After training, the MVO_2 increased by 11%, blood lactate by 21% and oxygen pulse by 13% in the T1 group.

As seen in most of these studies, the intensity of training was very often not controlled and it is known that this parameter is very difficult to control, especially in young children. It is generally noted that increases occurred in physical working capacities in Kpm/min, in max VO_2 l/min and in other related parameters, while a decrease in heart rates occurred in submaximal work. It is also possible to note that when measures are given by Kg body weight, only slight increases appear, and even the sexual differences tend to diminish. It is also very difficult to be definitely certain that the improvements in performance are due to training, since most of the studies were performed during the growth period and there is no way of eliminating one from the other.

FITNESS PERFORMANCE TESTS

Cumming and Keynes (16) have performed a study involving seven hundred Winnipeg school children using the CAHPER fitness performance test. The results were obtained from May 25 to 30, 1965 on four hundred and ninety-seven children of the original seven hundred. The tests consisted of speed sit-ups, standing broad jump, shuttle run, flexed arm hang, 50 yard run and 300 yard run. Students were not randomly

selected, but were students from two classes of each grade from 1 to 12 chosen by school principals. The mean results on the different items for the eight year old boys are as follow: subjects 39, sit-ups 27, broad jump 51 inches, arm hang 27 seconds, shuttle run 13 seconds, 50 yard run 9.3 seconds and 300 yard run 77 seconds. The correlation coefficient between each and every item varies from a low of -0.37 between the flexed arm hang and the 50 yard run to a high of -0.76 between shuttle run and broad jump and also 300 yard run and broad jump.

In 1966, the CAHPER, under the direction of Yuhasz and Hayden (24) conducted a study involving ten thousand boys and girls (aged seven to seventeen) on a battery of fitness performance items comprising: 50 yard dash, 300 yard run, shuttle run, flexed arm hang, standing broad jump and sit-ups. The mean values obtained for the eight year olds were: 50 yard run, 9.6 seconds; 300 yard run, 81 seconds; shuttle run, 13.5 seconds; standing broad jump, 47 inches; flexed arm hang, 27 seconds; one minute speed sit-ups, 24. These results and the results of all other age groups were used to establish the Canadian standard tables that are found in a booklet edited by the CAHPER.

These measures were taken on a normal population on one occasion, like most other studies involving measures on fitness performance items of the same type. Few studies used a fitness performance test as a measure of a possible increase in fitness after a period of training.

One study conducted by Bradley et al. (11) in 1967, at the University of Illinois Sports-Fitness Summer Day School for Boys determined the effects of an 8 week sports and physical fitness program on the physical fitness of boys aged seven to thirteen, sixty-five acting as the experimental group and twenty-two serving as the control group. The AAHPER physical fitness battery was administered with precautions to ensure that each test item was offered to both groups by the same proedures and examiner and on the same day, during the initial week (T1) and final week (T2) of the summer school. The two groups were matched only on the variables of age, height and weight, and after the initial test battery the experimental subjects participated for eight weeks in the activity program, each afternoon, consisting of 30 minutes in each of the following: aquatics, gymnastics, track and field, conditioning activities, and endurance running. Statistically significant changes were noted from T1 to T2 in the following items for the experimental group: (1) standing broad jump ($\bar{X}_1$ = 58.2 inches, $\bar{X}_2$ = 62.4); (2) sit-ups ($\bar{X}_1$ = 37.9, $\bar{X}_2$ = 84.5); (3) pull-ups ($\bar{X}_1$ = 2.08, $\bar{X}_2$ = 3.15); and (4) 600 yard run ($\bar{X}_1$ = 148.9 seconds, $\bar{X}_2$ = 138.0 seconds). For the control group, no statistically significant changes were noted from T1 to T2. The conclusions of the study stated that the changes which took place in items which purport to measure muscular strength and endurance were significantly greater for the boys in the organized program, and that no changes appeared for either group in the items which purport to measure speed, agility and coordination.

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STRENGTH MEASUREMENTS

Again in the literature, it is difficult to find strength test that measures such a parameter in young children of eight years of age. The studies we do find are purely measures taken in one testing session that serves to establish norms and classification.

A pilot study conducted by Torpey (40), in 1959, measured four hundred and fifty children using the leg extension test item. It was chosen because of ease of testing and because no discomfort on the child's part was expected. It was performed in a sitting position and only the right leg was tested. The means and standard deviations showed a steady increase with grade level going from 53 pounds in grade one to 95 pounds in grade six for the boys mean scores and from 14 to 20 for the standard deviation. The study was an attempt to determine the success with which a strength test could be conducted in a normal physical education class situation.

Montpetit _et al._ (38), in 1967, did a grip strength research on the Saginaw school children in Michigan, U.S.A., in which he tested a 6 percent sample of the children attending the public schools in 1962-63, using an ajustable grip dynamometer. The sample was made of four hundred and eighty-five boys and four hundred and twenty-three girls ranging in age from eight to seventeen years. The subjects had two trials with each hand, alternating right to left and with about one minute between trials. Each subject was tested in a standing position and was instructed to squeeze the dynamometer with a maximal effort

with the instrument held free from his body. The results of this sample are as follows for the eight year old boys group of twenty-two subjects: mean values for height was 129.4 cm, weight was 29.6 Kg and grip strength was 14.4 Kg. Only the better score with either hand was used.

The largest study in Canada made on strength was performed by Howell, Macnab et al. (25, 27) at the University of Alberta, in 1967. The sample included school children from Alberta as well as a sample of the Indian children of the province. A strength testing machine was constructed at the University of Alberta by Howell and Lucas, and consisted of a modification of one built by Hettinger in Germany. Eight of the ten strength measurements were carried out on the apparatus, the back and leg lift were done on separate apparatus. The strength of grip was tested for each grip by use of a Smedey Adjustable Grip dynamometer. The elbow flexion, elbow extension, knee extension were performed on the machine for each arm and each leg. The leg lift and back lift tests were done on a twelve inch stool placed against a flat wall. All measures on these tests were made with the Pacific Instrument cable tensiometer and recorded in pounds. The mean results for the boys eight years of age were as follows for the different items: right grip, 33 pounds; left grip, 32 pounds; right elbow flexion, 28 pounds; left elbow flexion, 27 pounds; right elbow extension, 25 pounds; left elbow extension, 25 pounds; right knee extension, 52 pounds; left knee extension, 51 pounds; leg lift strength, 145 pounds; back lift extension, 82 pounds. These strength measurements will serve as a basis for building provincial norms for the Alberta school children and Indian population.

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ICE HOCKEY SKILL TESTS

Research studies in ice hockey have been made mostly on skill items and technical moves. But a few studies concerned test making for hockey players.

Doroschuk and Marcotte (18) did a study to develop an efficient and objective mean of screening ice hockey players. The Illinois Agility run was adapted for use on ice and the test was administered to a hockey class. The sample was made of twenty-seven subjects all undergraduate students in physical education aged 18 to 25 years. The test was a puck control test in between the two blue lines and around chairs set 20 feet apart. The best of two trials was recorded. The times ranged from 25.6 seconds to 37.7 with a mean time of 27.4. The results indicated that the modified Illinois Agility Run could be used as a screening device to objectively and efficiently rate hockey players at initial try-outs, and also as a short objective test for hockey ability.

Merrifield and Walford (36) used fifteen male college students who were members of the Ithaca College Hockey club as subjects to develop a battery of ice hockey skill tests for the purpose of measuring selected basic skills in ice hockey. The test-retest method indicated four tests as reliable from a selection of six items based upon the subjective judgement of the two investigators. The tests included forward skating speed, backward skating speed, skating agility, puck carry, shooting and passing. The battery of tests was administered to

the subjects after one week of practice and was repeated one week later. The subjects performed two trials on each test item for each of the two test days. Scoring was done in seconds for the skating and puck carry items and in points for the shooting and passing. No results were available except concerning the validity and reliability of the test. The reliability coefficients ranged from 0.74 to 0.94 on the skating items and were of 0.62 for the shooting and 0.37 for the passing. The validity coefficients for each of the four skating tests when compared to subjective ranking in each skill ranged from 0.75 to 0.96. The puck carry test correlated with the other three tests and was determined the best single-item for measuring overall ability. It was concluded that an ice hockey test battery should include at least three of the tests.

Merrifield and Walford (37) during the winter of 1965 in Ithaca, New York, tested ninety-four boys in a Pee Wee hockey program using the battery of four ice hockey skill tests devised by themselves. Of the group tested, twenty-five were eight year olds, twenty-seven were nine, twenty-one were ten and twenty-one were eleven. Prior to the test period each subject was ranked, within his age category, on each of the four items by the head coach of his age bracket. All subjects were tested three weeks after the start of the program on four ice hockey skill tests: forward skating speed, backward skating speed, skating agility and puck carry. Two trials were given for each test item and data analysis was based upon the better performance of the two trials. The mean

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scores in seconds for the four age groups ranged from 29.97 for eleven year olds to 39.02 for eight year olds in the puck carry item, from 6.77 (eleven year olds) to 7.75 (eight year olds) in forward skating for 120 feet, from 10.57 (eleven year olds) to 14.25 (eight year olds) in backward skating for 120 feet and from 20.22 (eleven year olds) to 23.00 (eight year olds) in the agility item. As a result of this study, it appears that the eight and eleven year olds should be grouped homogeneously within their age bracket, whereas the data indicated little difference between the nine and ten year olds in the four skills.

Hockey Canada, under the investigation of Hansen et al. (23), is actually conducting a pilot study on a battery of hockey skills tests to develop norms per age and age group. The battery of tests will include four items: forward skating, backward skating, agility and puck control. On the forward and backward skating, measures will be taken at the 60 feet, 90 feet, 120 feet marks with the start on the net red line and the first mark at the first blue line, second mark at center red line and third mark at the far blue line. The agility item takes place in the center between any blue line and the center red line. The puck control test takes place between the net red line and the first blue line. The tests will be identical for all age groups. There is no data actually available but it appears that the following times per test are appropriate for the eight-nine years old group: forward skating 90 feet, 6.0 seconds; backward skating 90 feet, 9.0 seconds; agility, 13.0 seconds. No time was given for the 60 feet and 120 feet marks in

forward and backward skating and puck control items.

These studies on the construction of hockey skill tests for screening purposes or age grouping will help the coaches and trainers in the building of norms and teams.

CHAPTER III

METHODS AND PROCEDURES

SAMPLE

The twenty-eight subjects were children from the communities of Malmo and Michener Park in Edmonton and were all eight years of age as of December 31st 1973. The hockey group was a team of fourteen representing the Malmo community in the Little Richard League. Four of them were nine by the time the season ended. The control group was made of fourteen volunteer children, non-hockey players, from the same communities, and one of them was nine when the season ended. The hockey team finished second in the City of Edmonton for that age group.

TESTING CONDITIONS

The testing was done at the University of Alberta, in the main gymnasium for the fitness tests and in the physiology laboratories for the PWC_{170} and strength measurements. Neither the temperature nor the humidity were controlled. All subjects were tested before the hockey season started, in the third week of November 1973, for the hockey group, and the first week of December 1973 for the control group; the same subjects were tested again at the end of the season, after fifty games, in the first week of April 1974. For the hockey group, the hockey skill tests were held on an outside hockey rink, the pre-

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season on December 6th 1973, and the post-season on February 13th 1974, at 5:00 P.M. for both sessions. The temperature, both times, was between 15 and 25 degree F. above Zero, thus the ice conditions were different on each occasion. The activities done outside of the hockey practices and games were not controlled, for the hockey group, neither were the activities of the control group during the whole season.

TESTING PROCEDURE

Entering the room, before testing, the subjects were weighed in pounds and measured in inches on a Detecto-Medic scale. Bi-acromial and bi-iliac measures were taken with a millimetric L shaped ruler, with a sliding arm. Then the subjects were tested for a PWC_{170} on a modified Monar bicycle ergometer following the usual procedure as explained by Howell and Macnab (26). They pedalled for twelve minutes, in three periods of four minutes at increasing work loads to bring their heart rate up to or near a steady state of 170 beats per minutes. The heart rate was recorded on an E.C.G. Sanborn 500 Viso-Cardiette via patient leads connected to the subjects by three electrodes, two attached to his chest and one to his back on the right side.

Following the bike test on subsequent days, the subjects performed the "CAHPER fitness-performance tests" (24) in the main gymnasium:

a) the 50 yards was a timed straightaway sprint run in pairs;

b) the 300 yards was a timed six times 50 yards straightaway, back and forth around markers. It was also run in pairs;

c) the shuttle run was a back and forth run between two lines, thirty feet apart. The subjects had to pick up a small block from the far line, bring it and put it on the starting line, run back, pick a second block and run across the starting line. The subjects had to start lying on the floor, face down. The time was recorded in seconds;

d) the one-minute speed sit-up test in which the subject started from a back-lying position, knees flexed, feet flat on the floor, sat up and touched both elbows to his knees, then returned to the starting position. The number of times was recorded;

e) the standing broad jump in which a distance from a take-off line to the nearest point of reception from that line was measured in inches;

f) the flexed arm hang in which the subject tried to hang as long as possible from an horizontal bar. The time was recorded in seconds.

Strength measures were taken in the strength laboratory. A grip strength test was performed using a Stoelting adjustable grip dynamometer. Both hands were tested and the result of two contractions were recorded for each hand. The best result was retained. Using a modified model of the new Hettinger chair, built in the machine shop of the University of Alberta by the technical services, and equipped with a special seat for children, strength measures were taken on arm extension and flexion and knee extension, for the left side only.

Measures were made with a cable tensiometer model T5, serial number 10945, by Pacific Scientific Company, and calibrated before each session of testing. Conversion tables in pounds from the tensiometer units will be found on Appendix A. Two trials were performed for each test and the best one was recorded. The starting angle was 90° for all tests, with the arm parallel to the floor and the leg perpendicular to the floor.

DESCRIPTION OF HOCKEY SEASON

The hockey group had a season that went from the end of November 1973 to the beginning of April 1974 and was quite intensive for eight year old children. They played 50 games in this period, counting exhibition matches, scheduled league games, playoff and tournament games. They also had 20 official practices of one hour in duration. They were encouraged to skate as often as possible and averaged 41 times each of free skating. Thus the players averaged a total of 111 times on the ice during the season. All games were played on regulation ice surfaces and using regulation nets and pucks. Only 15 of the 50 games were played indoors.

STATISTICAL PROCEDURES AND EXPERIMENTAL DESIGN

A two-way analysis of variance fixed effects, with repeated measures on same subjects, factor B pre-post was used (Winer (48)). The two levels of factor A were the groups tested:

a) hockey group

b) control group.

The two levels of factor B were:

a) pre-season values

b) post-season values.

A one-way analysis of variance with repeated measures on the same subjects was used for the analysis of the hockey skill tests data (Winer (48)):

Factor A was: a) subjects

Factor B were: a) pre-season values

b) post-season values

Means and standard deviations were calculated for each parameter and will be found under each raw score columns, in Appendix E. All computations were made with the IBM 360 computer at the University of Alberta. The significance levels used were 0.01, 0.05 and 0.10 for all one-way and two-way Anova.

CHAPTER IV

RESULTS AND DISCUSSION

The statistical analysis summaries of each individual variable is found in Appendix C. A summary of the statistical analyses (Two Way Anova, Repeated Measures on One Variable) is included in Table V. The F values for A effects (Groups), B effects (Pre-Post) and AB interaction are given as well as an indication of the level of significance. Three levels of significance are reported, that is .01, .05 and .10. For the purpose of the discussion of results which follows the level of .10 is considered to be the minimum acceptable. The results of the ANOVA analysis for any given variable falls into one of six possible cases. A seventh where no significance is observed can be quickly dismissed. The six cases may be outlined as follows.

CASE 1

A, B and AB all significant.

There is a significant difference between groups, between testing periods (pre and post), and between the slopes of the improvement of the two groups. This latter observation would suggest that one group improved at a greater (or lesser) rate than the other.

CASE 2

A, B significant; AB not significant.

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There is a significant difference between groups and between testing periods but not between the slopes of the improvement of the two groups.

CASE 3

A significant, B and AB not significant.

There is a significant difference between groups but not between testing periods or between the slopes of improvement of the two groups.

CASE 4

B significant, A and AB not significant.

Same as case 3 but the significant difference exists between testing periods.

CASE 5

A significant, B not significant, AB significant.

There is a significant difference between groups, but not between testing periods. The significant interaction suggests that the slopes of improvement between the two groups is different.

CASE 6

A not significant, B significant, AB significant.

There is a significant difference between testing periods but not between groups. However the significant interaction suggests that one group may be improving at a greater rate than the other.

ANTHROPOMETRIC DATA

The physical characteristics of the subjects are reported in Table I. The post-season mean ages were 105.6 months for the hockey group and 103.5 months for the control group. Since four months separated the post-season testing and the pre-season testing, four subjects from the hockey group and one from the control group were nine years of age at the post-season testing. Chronologically, the hockey group was 2.1 months older than the control group. Names and dates of birth of all subjects are in Appendix B. In the case of height and weight there is a significant difference between testing periods but not between groups. However a significant interaction suggests that the hockey group may be increasing at a greater rate.

The mean height and mean weight of the control group increased respectively 0.25 inches and 1.2 pounds. The hockey group mean height increased 0.58 inches and the mean body weight increased 2.3 pounds, going from 59.7 to 62.0 pounds. The bi-iliac width increased very slightly, for both groups, however this increase was not statistically significant. The bi-acromial width increased significantly as indicated by the two-way Anova. A significant difference between testing periods was observed but not between groups. However, once again, the significant interaction suggests that one group may be improving at a

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TABLE I

CHARACTERISTICS OF THE SUBJECTS

(Means and Standard Deviations)

GROUPS		AGE (MONTHS)		HEIGHT (INCHES)		WEIGHT (POUNDS)		BI-ILIAC (CM)		BI-ACROMIAL (CM)	
		PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
CONTROL	M.	99.5	103.5	51.66	51.91	63.3	64.5	20.2	20.4	27.3	28.3
	S.D.	2.56	2.56	2.31	2.46	11.10	11.90	1.32	1.38	1.11	1.01
HOCKEY	M.	101.6	105.6	52.19	52.77	59.7	62.0	20.3	20.4	28.1	28.5
	S.D.	2.85	2.85	1.85	1.79	7.05	7.36	1.05	0.88	0.80	0.84

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greater rate than the other.

The mean of the control group increased 1.0 cm and the hockey group mean increased 0.4 cm. The data shows that the hockey group was taller than the control group, but lighter, although the increase in weight was greater in the hockey group.

RESULTS OF THE PHYSICAL WORKING CAPACITY TEST

The pre and post season values for the PWC_{170} are reported in Table II.

Following the post-season testing an increase of 42 Kpm/min (10.5%) was observed in the hockey group means compared to an increase of 15 Kpm/min (3.8%) for the control group. As for the PWC_{170}/Kg of body weight the observed increase in the hockey group means was 0.95 Kg compared to 0.26 Kg for the control group. A two way Anova for the PWC_{170} revealed a significant difference between testing periods but not between groups. However the significant interaction suggests that the hockey group may be improving at a greater rate than the control group. Identical findings appeared with the two-way Anova on the PWC_{170}/Kg.

TABLE II

PHYSICAL WORKING CAPACITY

(Means and Standard Deviations)

GROUPS		PWC_{170} Kpm/min		PWC_{170}/Kg body weight	
		PRE	POST	PRE	POST
CONTROL	M.	394	409	14.03	14.29
	S.D.	64.58	57.85	2.85	2.51
HOCKEY	M.	391	433	14.54	15.49
	S.D.	42.87	53.36	1.73	2.37
NATIONAL NORMS*	M.	351	361	12.71	12.72
	S.D.	92.00	91.51	2.94	2.84

* Children of same age.

RESULTS OF THE FITNESS PERFORMANCE

Pre and post values for the fitness performance items are reported in Table III.

50 yard run

The pre-season mean values were respectively 9.3 sec. for the control group and 9.0 sec. for the hockey group. The control group mean improved 0.3 sec. in the post-season test as compared to a 0.1 sec. improvement for the hockey group. However the two-way Anova reveals that there is a significant difference between groups and between testing peri[illegible] but not between the slopes of the improvement of the two groups.

300 yard run

Mean scores for the control group improved 1.5 sec. from pre-season to post-season, and the hockey group mean scores increased 1.9 sec. from pre to post-season. A two-way Anova showed a significant difference between groups and between testing periods but not between the slopes of the improvement of the two groups.

Shuttle run

The control group mean times were lowered from 13.4 sec. to 12.8 sec., on improvement of 0.6 of a second. The hockey group mean scores for the shuttle run improved 1.2 sec., from 13.0 sec. to 11.8 sec. A two-way Anova revealed a significant difference between groups,

between testing periods (pre-post), and between the slopes of the improvement of the two groups. This latter observation would suggest that the hockey group improved at a greater rate than the control group.

Flexed arm hang

Following the four month hockey season, the control group mean decreased 2.4 sec. compared to an increase of 18.1 sec. for the mean time score of the hockey group. A two-way Anova revealed a significant difference between groups, between testing periods (pre and post) and the slopes of the improvement of the two groups. This latter observation would suggest that the hockey group improved at a much greater rate than the control group.

Standing long jump

The mean scores of the control group were 52.24 inches at pre-season and 50.50 inches at post-season, a decrease in performance of 1.74 inches. The hockey group mean scores were 56.04 inches at pre-season and 55.70 inches at post-season, again a decrease of .34 inch. A two-way Anova showed a significant difference between groups but not between testing periods or between the slopes of improvement of the two groups.

Sit-ups

The pre-season mean scores for both groups, control and hockey, were respectively 19.9 and 33.2 times in one minute. The post-season

TABLE III

FITNESS PERFORMANCE ITEMS

(Means and Standard Deviations)

GROUPS		50 YARD (SEC)		300 YARD (SEC)		SHUTTLE RUN (SEC)		FLEX. ARM H. (SEC)		STAND. LONG JUMP (IN.)		1 MIN SPEED SIT-UPS	
		PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
CONTROL	M.	9.3	9.0	73.6	72.1	13.4	12.8	19.4	17.0	52.29	50.50	19.9	23.9
	S.D.	0.5	0.4	3.7	2.8	1.0	0.9	11.5	7.6	5.09	5.85	10.5	7.7
HOCKEY	M.	9.0	8.9	70.4	68.5	13.0	11.8	39.6	57.7	56.04	55.70	33.2	30.0
	S.D.	0.3	0.5	4.1	3.0	0.8	0.5	18.9	19.1	3.57	4.25	5.1	9.0
NATIONAL NORMS*	M.	9.7	9.5	80.5	79.4	13.5	13.3	28.4	29.2	48.0	49.0	23.5	29.3
	S.D.	1.0	-	9.3	-	1.27	-	20.3	-	7.4	-	8.9	-

* Children of same age.

mean scores were 23.9 for the control group, an increase of 4 times, and 30.0 for the hockey group, a decrease of 3.2 times from pre-season. The two-way Anova revealed a significant difference between groups, but not between testing periods. The significant interaction suggests that the slopes of improvement between the two groups is different.

RESULTS OF THE STRENGTH MEASUREMENTS

The pre and post values for the strength items are reported in Table IV.

Grip strength left and right

The mean scores for the control group increased 3.1 pounds (36.1 to 39.2) for the left grip and 1.7 pounds (38.0 to 39.7) for the right grip. The hockey group mean scores increased 3.9 pounds (39.4 to 43.3) for the left grip and 2.9 pounds (40.0 to 42.9) for the right grip. A two-way Anova performed on the means revealed a significant difference between testing periods but not between groups or between the slopes of improvement for the two groups.

Arm strength (arm extension and arm flexion, left only)

Mean scores for the control group improved from 14.0 pounds to 16.2 pounds (2.2 pounds) in arm extension, from pre to post-season, and a decrease from 19.3 to 18.8 pounds (0.5 pound) was noticed in arm flexion strength. The hockey group mean scores improved 4.4 pounds

TABLE IV

STRENGTH MEASUREMENTS

(Means and Standard Deviations)

GROUPS		GRIP LEFT		GRIP RIGHT		ARM EXT.		ARM FLEX.		KNEE EXT.	
		PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
CONTROL	M.	36.1	39.2	38.0	39.7	14.0	16.2	19.3	18.8	38.9	41.6
	S.D.	6.8	6.5	6.3	6.4	3.9	5.9	5.1	6.1	9.5	7.0
HOCKEY	M.	39.4	43.3	40.0	42.9	12.5	16.9	18.8	20.4	42.0	42.5
	S.D.	6.2	7.4	7.3	6.5	3.8	4.9	4.4	3.9	9.7	9.7

N.B. All measures are in pounds.

TABLE V

TWO-WAY ANOVA WITH REPEATED MEASURES ON SAME SUBJECTS

ANALYSIS OF VARIANCE RESULTS (F VALUES)

	A EFFECTS (GROUPS)	B EFFECTS (PRE-POST)	AB INTERACTION
HEIGHT	0.70	20.38***	2.84*
WEIGHT	0.66	56.59***	5.40*
BI-ILIAC	0.006	1.64	1.01
BI-ACROMIAL	2.39	24.04***	3.50*
50 YARDS	2.77*	5.70*	0.78
300 YARDS	8.03***	8.02***	0.07
SHUTTLE RUN	5.69**	35.98***	3.77*
FLEX. ARM HANG	37.26***	6.00**	9.95***
STAND. LONG JUMP	7.28***	1.49	0.70
SIT-UPS	11.24***	0.08	5.93**
GRIP STRENGTH (LEFT)	2.01	30.30***	0.47
GRIP STRENGTH (RIGHT)	1.14	6.34**	0.44
ARM STRENGTH (ARM EXT.)	0.06	18.97***	2.14
ARM STRENGTH (ARM FLEX.)	0.06	0.74	2.78
LEG STRENGTH (KNEE EXT.)	0.37	1.65	0.77
PWC_{170}	0.24	23.62***	5.16**
$PWC_{170/Kg}$	0.84	9.28***	3.02*

N.B. Significant at .01 ***, at .05 **, at .10 *.

(12.5 to 16.9 pounds) in arm extension and 1.6 pound (18.8 to 20.4 pounds) in arm flexion. A two-way Anova showed, for the arm extension, that a significant difference exists between testing periods, not between groups or between the slopes of improvement of the two groups. For the arm flexion, no significant difference were found.

Leg strength (knee extension for left leg only)

No significant increase was noticed for the knee extension and for both groups the improvement was very small with the control group mean increasing 2.7 pounds and the hockey group mean improving only by 0.5 pound.

RESULTS OF THE ICE HOCKEY SKILL TESTS

Pre and post values will be found in Table VI.

The one-way analysis of variance results (F values) is reported in Table VII for each item. The statistical analysis summaries of each item are found in Appendix D.

Forward skating

No significant difference was observed in the mean times between pre and post-testing at 60, 90 or 120 feet. A non-significant improvement of 0.2 of a second was noted in the 120 feet times.

Backward skating

No significant difference was observed for 60 and 120 feet.

However a significant improvement was observed for the 90 feet test. The increase from pre to post-testing in the 60 feet time was 0.1 second. In the 90 feet test, the mean time improved from 7.9 to 7.7 seconds. For the 120 feet mean scores improved 0.3 second.

Agility

Here, the one-way Anova performed on the means showed a significant improvement in the mean times from pre to post-testing. The post-season mean time was 1 second better than the pre-season mean time going from 13.7 to 12.7 seconds.

Puck control

The mean scores improved 0.9 second from pre to post-testing. That improvement was significant as shown by the one-way Anova.

TABLE VI

HOCKEY SKILL TESTS FOR HOCKEY GROUP

(Means and Standard Deviations)

		FRONT SKATING			BACK SKATING			AGILITY	PUCK CONTROL
		60'	90'	120'	60'	90'	120'		
PRE	M.	3.6	5.0	6.7	5.5	7.9	10.5	13.7	19.4
	S.D.	0.1	0.2	0.2	0.5	0.6	0.9	0.9	1.4
POST	M.	3.6	5.0	6.5	5.4	7.7	10.2	12.7	18.5
	S.D.	0.2	0.2	0.3	0.3	0.6	0.6	0.6	1.1

N.B. All scores in seconds.

TABLE VII

ONE-WAY ANOVA WITH REPEATED MEASURES ON SAME SUBJECTS

ANALYSIS OF VARIANCE RESULTS (F VALUES)

HOCKEY SKILL TESTS

		TREATMENTS EFFECTS (PRE-POST)
SKATING FORWARD	60'	0.28
	90'	0.78
	120'	1.77
SKATING BACKWARD	60'	0.76
	90'	4.49**
	120'	2.92
AGILITY		22.96***
PUCK CONTROL		4.16*

N.B. Significant at .01 ***, at .05 **, at .10 *.

DISCUSSION

Two unique characteristics of this study are: first, it has been performed on boys of eight years of age whereas most other studies (2, 3, 8, 10, 12, 15, 17, 19, 20, 28, 33, 38, 42, 46) have been performed on older children, and second, it involves training at a relatively high intensity. The boys played hockey on a highly competitive level, during a season which lasted four months. The frequency of games, practices and skating time was fairly high for eight year old boys. Most studies involving eight year old boys (1, 9, 12, 14, 16, 24, 25, 26, 27, 40) have not taken into account a training factor and have been merely normative measures of the physical working capacity (1, 9, 14, 16, 26, 27), physical strength (25, 27, 40) and performance of children on specific items (16, 24, 27). It is then possible to compare the pre-season results of this study for both control and hockey groups to measures obtained from these studies. These comparisons indicate, possibly, the difference, if any, in the level of fitness between the groups in this study and other boys of the same age. The mean scores are compared. In Adams *et al.* (1) the eight year old boys who were studied (11 subjects) had a mean height of 52.4 inches and a mean weight of 66 pounds. Their physical working capacity mean score was 438 Kgm/min. Like most other studies, the work of Adams *et al.* pointed out the very high correlation of physical work capacity with surface area, height and weight. The study emphasized the fact that boys

possess significantly greater working capacities than girls, even at a smaller surface area. Cumming and Cumming (14) performed a similar analysis on Winnipeg school population. Their five subjects of eight years of age had a mean height of 52.8 inches and a mean body weight of 66 pounds. The mean score for the PWC_{170} was 457 Kgm/min. Preliminary observations in that study suggest that the working capacity of Winnipeg children is slightly lower than that of children studied on the same type of bicycle in Sweden and California. Possible reasons for this state of affairs were discussed. Working capacities of children of high academic standing tended to be lower than average, but working capacities of private school children exposed to more physical training tended to be higher than average. Neither of these two studies reported values on the PWC_{170} per Kg of body weight. However they can be calculated from the data presented. The CAHPER study by Howell and Macnab (26) reported for their 101 subjects (age eight) a mean body weight of 60.8 pounds, and mean scores on the PWC_{170} of 351 Kpm/min. and 12.71 Kpm/min. per Kg of body weight.

The analysis of the data obtained in the Canadian study indicates a continuous increase in mean PWC_{170} for each age group observed in the male sample. Throughout the entire age range the males are superior to the females. Expressing the work capacity data as PWC_{170}/Kg of body weight reveals a rather steady value for males throughout the entire age range. It has also been found that when the correlation coefficients are calculated over the whole age range investigated, it increases remarkably.

In the present study, the 14 subjects of the control group (age eight) had mean scores of 51.6 inches for height, 63.3 pounds for weight, 394 Kpm/min. on the PWC_{170} and 14.03 Kpm/Kg of body weight. These subjects were slightly smaller in size and weight of the Adams' and Cumming's subjects. The PWC_{170} values were much lower since they had a mean of 394 Kpm/min. compared to 438 and 457 Kpm/min. But the control group in this study had higher mean results than the CAHPER sample since the mean score was 351 Kpm/min. compared to 394 Kpm/min. and 12.71 to 14.03 Kpm/Kg of body weight. The control sample of fourteen boys were heavier than the Canadian sample (mean weight of 63.3 compared to 60.8 pounds). The hockey group of this study (14 subjects of eight years of age) had mean scores of 52.19 inches for height, 59.7 pounds for weight, 391 Kpm/min. on the PWC_{170} and 14.54 on the PWC_{170}/Kg of body weight. Again these subjects were lighter and shorter than Cumming's and Adams' sample, and had a lower mean scores on the PWC_{170}. Since they had equal or better scores than the control group, they were also better than the Canadian sample. A summary of the different studies (Table VIII) emphasizes the obtained results. It should be emphasized that only in the study of Howell and Macnab (26) was a large number of subjects studied in order to establish mean values.

[illegible]

TABLE VIII

COMPARED RESULTS OF PHYSICAL WORK CAPACITY

AUTHOR	PLACE	SEX	NUMBER	AGE	HEIGHT (INCHES)	WEIGHT (POUNDS)	PWC_{170}	PWC_{170}/Kg
ADAMS	California (USA)	M	11	8	52.4	66.0	438	14.60
CUMMINGS	Winnipeg	M	5	8	52.8	66.0	457	15.23
HOWELL & MACNAB	Canada	M	101	8	-	60.8	351	12.71
THIBAULT	Edmonton	M	14	8	51.6(C)	63.3	394	14.03
		M	14	8	52.2(H)	59.7	391	14.54

Analyzing these compared results, we can assume that both groups in this study fit in the normal Canadian population and even say that their physical working capacity is slightly better than the normal population. Since no studies have been performed on eight year old boys involved in training it is then impossible to compare the post-season results of this study with any other ones. Examining the results closely, the two-way ANOVA indicated a significant increase from pre to post season as well as a significant interaction for both the PWC_{170} and PWC_{170}/Kg body weight. On the PWC_{170} the mean scores of both groups at pre-season were respectively 394 Kpm/min. (control group) and 391 Kpm/min. (hockey group). The hockey group mean score increased to 433 Kpm/min., a difference of 42 Kpm/min. from pre-season compared to an increase of 15 Kpm/min. for the control group. Per Kg of body weight both groups also increased their mean scores, 0.26 Kpm/Kg for the control group and 0.95 Kpm/Kg for the hockey group. Since the hockey group was lighter than the control, even at post-season (64.5 pounds to 62.0 pounds), and since the AB interactions are significant it may be suggested that the significant increase in both Kpm/min. and Kpm/Kg of body weight for the hockey group over the control group is due to the influence of the hockey season, in fact to training.

This suggestion might be reflected in the other parameters studied. Bradley (11) in a study at the University of Illinois used the AAHPER physical fitness test to examine the influence of eight-week of sports and physical training on the physical fitness of

boys between the ages of seven and thirteen inclusively. No age group results are given, but on similar items used in his study and the present one, comparisons are of interest. In the 50 yard run, his subjects had mean times of 9.0 seconds (pre-test) and 8.8 seconds (post-test). The control group in this study had mean times of 9.3 seconds and 9.0 seconds and the hockey group recorded mean scores of 9.0 seconds and 8.9 seconds, which compare well with Bradley's results. The standing broad jump mean results show a much better performance in the Illinois study: 58.2 inches and 62.4 inches respectively in pre and post-test. The control group in this study had mean scores of 52.29 inches and 50.50 inches respectively, and the hockey group mean scores were 56.04 inches and 55.70 inches. No explanation is apparent to explain the decrease in long jump results for both groups in the present study. The shuttle run mean scores were also much better in the Illinois study, as well as the sit-ups mean scores. Based on the investigation, Bradley's conclusions were that the changes which took place in items which purport to measure muscular strength and endurance, power and cardiorespiratory endurance were significantly greater for the boys in the organized program. No changes appeared in the items which measure speed, agility and coordination. Cumming and Keynes (16) used the same test as the present study to measure the fitness of Winnipeg school children (39 subjects, boys aged eight) and correlated the results with their physical working capacity and maximal oxygen uptake. In addition Hayden and Yuhasz (24) performed a national study involving 11,000 subjects from seven to seventeen years of age

from which national norms were established. The sample of eight year old boys totaled 580. In Table IX are the mean results of these two studies and the mean scores of both groups (pre-season) from this study.

The analysis shows that both groups from this study compare very well with the studies of Cumming and Keynes (16) and Hayden and Yuhasz (24). On five of the six items, the hockey group mean scores (pre-season) were better than the scores for the other two studies. In fact, the mean score for the hockey group exceeded the 90th% for the 300 yards, the 85th% for the standing broad jump and speed sit-ups and the 75th% for the flexed arm hang and the 50 yards in the Hayden and Yuhasz study. The shuttle run mean scores were equal. The control group of this study had better mean scores than the two mentioned studies in the 300 yard run and the standing broad jump, but lower scores in the sit-up test and the flexed arm hang. These compared results indicate that the hockey group of this study is well above average. Statistical analysis revealed that while a difference existed between groups and between pre and post-season, no difference in improvement slope existed in favor of the hockey group for the 300 yards and 50 yards. In the case of the shuttle run and the flexed arm hang similar statistical results were obtained except that a suggestion of increased rate of improvement on the part of the hockey group is indicated. In the standing long jump only a significant difference between groups was observed. In the case of the speed sit-ups the hockey group was superior but decreased slightly during

TABLE IX

COMPARED RESULTS OF FITNESS PERFORMANCE TEST

AUTHOR	NUMBER OF SUBJECTS	50 YARD (SEC)	300 YARD (SEC)	SHUTTLE RUN (SEC)	FLEX. ARM H. (SEC)	STAND. LONG JUMP (IN.)	1 MIN. SPEED SIT-UPS
CUMMING	39	9.3	77.0	13.0	27.0	51	27
CAHPER	580	9.5	78.0	13.3	23.0	47	24
THIBAULT	14(C)	9.3	73.6	13.4	19.4	52	20
	14(H)	9.0	70.9	13.0	39.6	56	33

the season while the control group increased slightly. In general with these mean post-season scores, the hockey group has much better results than the control group and the other studies referred to.

Two studies reported measures of strength taken on young children including eight year old boys. Both studies emphasized the fact that strength increases regularly with age and is a function of growth. Torpey (40) reported a mean score of 70 pounds on the leg extension test of 40 boys of grade three, with no specification of age or weight of his subjects. Howell _et al._ (25) studied a sample of the Alberta school population and did a much more sophisticated analysis of strength. In Table X, the mean scores (in pounds) of Howell _et al._'s are compared with the mean scores (pre-season) of both groups of this study, for eight year old subjects.

These compared measures indicate that the Alberta sample was much stronger than this sample on arm extension, arm flexion and knee extension. But the sample from the present study had higher mean scores in both left and right grip strength. Although significant increases were noticed in the left grip strength and the arm extension, and also in the right grip strength, the mean post-season scores were still much lower than the mean scores of the Alberta sample on these three specific items, namely arm extension, arm flexion and knee extension. An explanation of the above results is difficult. It should be mentioned, however, that calibrations and standardized procedures are difficult using the strength chair and cable tensio-

TABLE X

COMPARED RESULTS OF STRENGTH MEASUREMENTS (POUNDS)

AUTHOR	NUMBER OF SUBJECTS	GRIP LEFT	GRIP RIGHT	ARM EXT.	ARM FLEX.	KNEE EXT.
HOWELL		32.0	33.0	25.0	27.0	51.0
THIBAULT	14(C)	36.1	38.0	14.0	19.3	38.9
	14(H)	39.4	40.0	12.5	18.8	42.0

meter techniques. Further study is recommended to verify the observed differences.

One of the main objects of this study was to measure the influence of a hockey season on the physical fitness of eight year old boys. As it was indicated earlier, very few studies have been performed on hockey players, specifically examining the effect of playing hockey, competitively and intensively, as a means of training and increasing the physical fitness of young children. It was appropriate to include in this study measurements on a hockey skill test developped by Hansen et al. (23) for Hockey Canada. As of yet, no data is available from that pilot study, therefore no comparison can be made with this study's data. Merrifield and Walford (37) did perform a study on eight to eleven year old boys in Ithaca, New York, on specific hockey items. The only possible comparison with this study was on the forward and backward skating (120 feet) where mean times, for eight year old boys, were respectively 7.75 seconds and 14.25 seconds, which is much slower than the present sample mean pre-season scores of 6.7 seconds and 10.5 seconds for the same items. Of course, this sample of fourteen hockey players was not an ordinary group for that age bracket, since they had a four month season, played fifty games and finished second in their age group for the city of Edmonton championship.

The only significant improvements in the skating tests were in the agility item and in backward skating (90 feet). Otherwise, the results were very close from pre to post-season. It should be recalled that the hockey skill tests were performed on an outside skating rink

and thus that ice conditions were not identical from pre to post-testing. These ice conditions might have influenced the performance of the hockey group.

CHAPTER V

SUMMARY AND CONCLUSIONS

The influence of a four month hockey season on the physical fitness of children was determined on a group of fourteen hockey players of eight years of age and compared with the fitness of fourteen non-hockey players of the same age. The tests used were as follows: PWC_{170} on a bicycle ergometer, a fitness performance test, certain strength measurements, plus some anthropometric data. In addition, the hockey group performed a hockey skill test.

For the anthropometric measures, significant increases were noticed in the height, weight and bi-acromial items from pre to post-testing. Identical findings occurred in the PWC_{170} and PWC_{170}/Kg of body weight. In all six items of the fitness performance tests, significant differences were found between groups and significant improvements were found in four of the six items. As far as strength is concerned, in the grip strength left and right and the arm extension significant increases were found from pre to post-testing. In the hockey items for the hockey group, significant increases between testing periods were found in backward skating (90 feet), in the agility and puck control tests.

However, in some items, no significant differences between groups and no significant improvements were evident. These items included: bi-iliac measures, arm strength (arm flexion) and leg

[illegible]

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[illegible]

strength (knee extension). Also looking at the hockey skill test results, no significant improvements were found in forward skating for 60 feet, 90 feet and 120 feet and backward skating in the 60 feet and 120 feet items.

Examining the results of the anthropometric data, significant pre-post season increases in height, weight and bi-acromial measures were found. Although the literature is not clear on the subject of the effect of physical training on growth rate in children the significant AB interaction in the present study for height and weight suggests a more rapid growth for the hockey group in their four month hockey season. This larger increase may involve effects from training and playing hockey.

Since statistically significant increases were found for the PWC_{170} (10.5% for the hockey group and 3.8% for the control group) it is possible to suggest a training effect from the hockey season for that group. The 3.8% increase of the control group is probably due to normal growth. The significant increases in the PWC_{170}/Kg of body weight also suggest an effect of training for the hockey group. Once again the control group increase (.26) is probably a result of growth. The increase of .95 for the hockey group might again indicate a training effect from the hockey season that would support the similar finding on the PWC_{170}.

Since significant differences were found between groups in all six items of the physical fitness test, it is possible to conclude that the hockey group, because of their better scores in all six items,

was superior to the control group at the beginning of the season. Examining the significant pre-post season increases in four of the six items, it is possible to point out that the small increase on the 50 yard run favours the control group; the hockey group had a larger increase in the 300 yard run, 1.9 second to 1.5 second, but it is difficult to suggest a training effect here. In the shuttle run, the increase was again larger for the hockey group but again it is difficult to imply a training effect. However on the flexed arm hang test, the control group suffered a decrease while the hockey group had a large increase of 18.1 seconds. This may be explained by a training effect of the hockey season, but also by the desire of the hockey group to perform well, since a good result on this item may reflect desire and drive, as much as pure strength. But the significant results of the strength tests, especially grip strength, emphasize the flexed arm hang high score for the hockey group. The hockey group was far superior to the control group at the beginning and end of the season in speed sit-ups. However they did not improve during the season probably due to their high performance on this item. It is very difficult to improve beyond 40 sit-ups per minute.

No training effect for the strength measures was revealed by the statistical analyses performed. In fact no significant difference between the two groups was demonstrated. The significant pre-post season increases for both groups are attributable to normal growth.

In the hockey skill tests, significant increases were found in backward skating (90 feet), the agility test and the puck control test. These increases were small and it is surprising that greater increases in these items, and significance in all other items was not found. Three factors probably contributed to these results. The first ice conditions has previously been discussed. The second was that for these items only two months separated the pre and post-testing sessions. The third was that most of the hockey group had attended two or more hockey schools before the season began.

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APPENDICES

APPENDIX A

Calibration table for the bicycle ergometer

Conversion table for the cable tensiometer

CALIBRATION TABLE FOR THE BICYCLE ERGOMETER

KP SETTING	CALIBRATION A ACTUAL KP	CALIBRATION B ACTUAL KP
0.5	0.220	0.150
1.0	0.430	0.361
1.5	0.665	0.594
2.0	0.870	0.800
2.5	1.080	1.010
3.0	1.300	1.235
3.5	1.510	1.439
4.0	1.740	1.670

N.B. In all PWC_{170} testing a small modified pendulum was used. This pendulum was identical to that used by Howell and Macnab (26).

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[illegible]	[illegible]	[illegible]
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	[illegible]	[illegible]
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[illegible]		[illegible]
[illegible]		[illegible]

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[illegible]

CONVERSION TABLE FOR THE CABLE TENSIOMETER

POUNDS (PRE-SEASON)	TENSIOMETER UNIT	POUNDS (POST-SEASON)
2.513	1	2.949
5.026	2	5.341
7.539	3	7.734
10.052	4	10.127
12.565	5	12.519
15.078	6	14.912
17.591	7	17.305
20.104	8	19.697
22.617	9	22.090
25.130	10	24.483
27.643	11	26.875
30.156	12	29.268
32.669	13	31.661
35.182	14	34.053
37.695	15	36.446
40.208	16	38.839
42.721	17	41.231
45.234	18	43.624
47.747	19	46.017
50.260	20	48.409
52.773	21	50.802
55.286	22	53.195
57.799	23	55.588
60.312	24	57.980
62.825	25	60.373

APPENDIX B

Subjects' names and dates of birth

SUBJECTS

HOCKEY GROUP

NAME	DATE OF BIRTH (DAY, MONTH, YEAR)
ANTONIUK M.	12 - 01 - 65
CARLSON R.	11 - 06 - 65
DONADT R.	26 - 03 - 65
DONALD S.	24 - 06 - 65
HOLGATE B.	16 - 12 - 65
JONES B.	06 - 09 - 65
LEISEN B.	13 - 07 - 65
LUND G.	12 - 07 - 65
LUND T.	12 - 07 - 65
MACNAB B.	16 - 07 - 65
MILLIGAN P.	21 - 04 - 65
ROBERGE D.	15 - 02 - 65
TKACHUK S.	25 - 02 - 65
WOZNIAK L.	03 - 09 - 65

SUBJECTS

CONTROL GROUP

NAME	DATE OF BIRTH (DAY, MONTH, YEAR)
BELLOW J.	19 - 07 - 65
BETTCHER D.	03 - 09 - 65
CHABUN A.	08 - 12 - 65
COLVIN T.	18 - 09 - 65
DEVLIN J.	17 - 05 - 65
GYNANE S.	01 - 04 - 65
HALLS G.	03 - 01 - 66
McLEOD S.	22 - 09 - 65
McPHERSON K.	21 - 06 - 65
MISSOURI D.	08 - 10 - 65
MITTAL P.	13 - 05 - 65
OOSTERHUIS E.	31 - 08 - 65
SZASZKIEWICZ P.	30 - 10 - 65
WOZNEY D.	15 - 06 - 65

APPENDIX C

Summaries of two-way Analysis of Variance on Anthropometric Data, Fitness Performance, Strength and Physical Working Capacity tests

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (HEIGHT)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	257.437	27			
'A' MAIN EFFECTS	6.781	1	6.781	0.703	0.4093160
SUBJECTS WITHIN GROUPS	250.687	26	9.642		
WITHIN SUBJECTS	5.687	28			
'B' MAIN EFFECTS	2.352	1	2.352	20.380	0.0001220
'A*B' INTERACTION	0.328	1	0.328	2.844	0.1036969
'B' X SUBJ. WITHIN GROUPS	3.000	26	0.115		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (WEIGHT)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	5274.750	27			
'A' MAIN EFFECTS	130.813	1	130.818	0.661	0.4235236
SUBJECTS WITHIN GROUPS	5143.937	26	197.844		
WITHIN SUBJECTS	67.750	28			
'B' MAIN EFFECTS	43.531	1	43.531	56.591	0.0000005
'A*B' INTERACTION	4.156	1	4.156	5.403	0.0281805
'B' X SUBJ. WITHIN GROUPS	20.000	26	0.769		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (BI-ILIAC)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	74.105	27			
'A' MAIN EFFECTS	0.017	1	0.017	0.006	0.9388664
SUBJECTS WITHIN GROUPS	74.094	26	2.850		
WITHIN SUBJECTS	3.676	28			
'B' MAIN EFFECTS	0.212	1	0.212	1.648	0.2105842
'A*B' INTERACTION	0.130	1	0.130	1.010	0.3241822
'B' X SUBJ. WITHIN GROUPS	3.344	26	0.129		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (BI-ACRO)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	47.090	27			
'A' MAIN EFFECTS	3.965	1	3.965	2.391	0.1341190
SUBJECTS WITHIN GROUPS	43.113	26	1.658		
WITHIN SUBJECTS	16.070	28			
'B' MAIN EFFECTS	7.219	1	7.219	24.048	0.0000442
'A*B' INTERACTION	1.053	1	1.053	3.507	0.0723996
'B' X SUBJ. WITHIN GROUPS	7.805	26	0.300		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (50 YARDS)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	9.562	27			
'A' MAIN EFFECTS	0.923	1	0.923	2.778	0.1075629
SUBJECTS WITHIN GROUPS	8.637	26	0.332		
WITHIN SUBJECTS	3.406	28			
'B' MAIN EFFECTS	0.598	1	0.598	5.704	0.0244814
'A*B' INTERACTION	0.082	1	0.082	0.782	0.3845649
'B' X SUBJ. WITHIN GROUPS	2.727	26	0.105		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (300 YARDS)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	705.688	27			
'A' MAIN EFFECTS	166.633	1	166.633	8.031	0.0087728
SUBJECTS WITHIN GROUPS	539.438	26	20.748		
WITHIN SUBJECTS	172.625	28			
'B' MAIN EFFECTS	40.633	1	40.633	8.022	0.0088060
'A*B' INTERACTION	0.383	1	0.383	0.076	0.7855509
'B' X SUBJ. WITHIN GROUPS	131.687	26	5.065		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (SHUTTLE RUN)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	F
BETWEEN SUBJECTS	36.262	27			
'A' MAIN EFFECTS	6.515	1	6.515	5.693	0.0246065
SUBJECTS WITHIN GROUPS	29.754	26	1.144		
WITHIN SUBJECTS	22.574	28			
'B' MAIN EFFECTS	12.353	1	12.353	35.982	0.0000031
'A*B' INTERACTION	1.295	1	1.295	3.773	0.0629806
'B' X SUBJ. WITHIN GROUPS	8.926	26	0.343		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (FLEX. ARM HANG.)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	22005.715	27			
'A' MAIN EFFECTS	12962.582	1	12962.582	37.269	0.0000026
SUBJECTS WITHIN GROUPS	9043.188	26	347.815		
WITHIN SUBJECTS	6154.000	28			
'B' MAIN EFFECTS	880.031	1	880.031	6.000	0.0213532
'A*B' INTERACTION	1460.649	1	1460.649	9.959	0.0040193
'B' X SUBJ. WITHIN GROUPS	3813.250	26	146.663		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (STAND. LONG. JUMP)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	1282.312	27			
'A' MAIN EFFECTS	280.766	1	280.766	7.289	0.0120381
SUBJECTS WITHIN GROUPS	1001.562	26	38.522		
WITHIN SUBJECTS	297.375	28			
'B' MAIN EFFECTS	15.750	1	15.750	1.493	0.2326914
'A*B' INTERACTION	7.383	1	7.383	0.700	0.4104344
'B' X SUBJ. WITHIN GROUPS	274.250	26	10.548		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (SIT-UP)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	4440.500	27			
'A' MAIN EFFECTS	1340.637	1	1340.637	11.245	0.0024580
SUBJECTS WITHIN GROUPS	3099.859	26	119.225		
WITHIN SUBJECTS	964.000	28			
'B' MAIN EFFECTS	2.570	1	2.570	0.085	0.7724750
'A*B' INTERACTION	178.579	1	178.579	5.931	0.0220430
'B' X SUBJ. WITHIN GROUPS	782.859	26	30.110		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (GRIP LEFT)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	2606.187	27			
'A' MAIN EFFECTS	187.578	1	187.578	2.016	0.1674856
SUBJECTS WITHIN GROUPS	2418.625	26	93.024		
WITHIN SUBJECTS	319.375	28			
'B' MAIN EFFECTS	170.406	1	170.406	30.307	0.0000095
'A*B' INTERACTION	2.680	1	2.680	0.477	0.4960864
'B' X SUBJ. WITHIN GROUPS	146.187	26	5.623		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (GRIP RIGHT)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	2306.875	27			
'A' MAIN EFFECTS	96.961	1	96.961	1.141	0.2953052
SUBJECTS WITHIN GROUPS	2209.875	26	84.995		
WITHIN SUBJECTS	362.562	28			
'B' MAIN EFFECTS	70.164	1	70.164	6.345	0.0182551
'A*B' INTERACTION	4.867	1	4.867	0.440	0.5128841
'B' X SUBJ. WITHIN GROUPS	287.500	26	11.058		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (ARM EXT.)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	1052.066	27			
'A' MAIN EFFECTS	2.485	1	2.485	0.062	0.8060054
SUBJECTS WITHIN GROUPS	1049.582	26	40.369		
WITHIN SUBJECTS	377.000	28			
'B' MAIN EFFECTS	151.806	1	151.806	18.974	0.0001847
'A*B' INTERACTION	17.158	1	17.158	2.145	0.1550666
'B' X SUBJ. WITHIN GROUPS	208.023	26	8.001		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (ARM FLEX.)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	1216.496	27			
'A' MAIN EFFECTS	3.028	1	3.028	0.065	0.8009391
SUBJECTS WITHIN GROUPS	1213.469	26	46.672		
WITHIN SUBJECTS	172.480	28			
'B' MAIN EFFECTS	4.354	1	4.354	0.746	0.3957891
'A*B' INTERACTION	16.273	1	16.273	2.786	0.1070864
'B' X SUBJ. WITHIN GROUPS	151.859	26	5.841		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (KNEE EXT.)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	4093.562	27			
'A' MAIN EFFECTS	58.789	1	58.789	0.379	0.5435804
SUBJECTS WITHIN GROUPS	4034.812	26	155.185		
WITHIN SUBJECTS	621.500	28			
'B' MAIN EFFECTS	36.148	1	36.148	1.654	0.2098078
'A*B' INTERACTION	17.008	1	17.008	0.778	0.3858330
'B' X SUBJ. WITHIN GROUPS	568.375	26	21.861		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (PWC_{170})

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	167980.000	27			
'A' MAIN EFFECTS	1554.001	1	1554.001	0.243	0.6263456
SUBJECTS WITHIN GROUPS	166426.000	26	6401.000		
WITHIN SUBJECTS	25781.000	28			
'B' MAIN EFFECTS	11116.004	1	11116.004	23.622	0.0000497
'A*B' INTERACTION	2431.626	1	2431.626	5.167	0.0315149
'B' X SUBJ. WITHIN GROUPS	12235.000	26	470.577		

TWO WAY ANOVA WITH REPEATED MEASURES ON ONE FACTOR (PWC_{170}/Kg)

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SS	DF	MS	F	P
BETWEEN SUBJECTS	319.777	27			
'A' MAIN EFFECTS	10.090	1	10.090	0.847	0.3658363
SUBJECTS WITHIN GROUPS	309.688	26	11.911		
WITHIN SUBJECTS	21.035	28			
'B' MAIN EFFECTS	5.100	1	5.100	9.287	0.0052443
'A*B' INTERACTION	1.661	1	1.661	3.025	0.0938195
'B' X SUBJ. WITHIN GROUPS	14.277	26	0.549		

APPENDIX D

Summaries of one-way Analysis of Variance

on items of the Hockey Skill tests

ONE WAY ANOVA WITH REPEATED MEASURES (FRONT SKATING 60 FEET)

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN PEOPLE	0.82690430	13.	0.63607991	
WITHIN PEOPLE	0.58007813	14.	0.41434150	
TREATMENTS	0.12451172	1.	0.12451172	0.2852
RESIDUAL	0.56762695	13.	0.43663610	
TOTAL	0.14069824	27.		

PROB. OF F = 0.60233

ONE WAY ANOVA WITH REPEATED MEASURES (FRONT SKATING 90 FEET)

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN PEOPLE	0.11062012	13.	0.85092366	
WITHIN PEOPLE	0.75341797	14.	0.53815566	
TREATMENTS	0.42724609	1.	0.42724609	0.7815
RESIDUAL	0.71069336	13.	0.54668717	
TOTAL	0.18596191	27.		

PROB. OF F = 0.39272

ONE WAY ANOVA WITH REPEATED MEASURES (FRONT SKATING 120 FEET)

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN PEOPLE	0.11523437	13.	0.88641822	
WITHIN PEOPLE	0.85351563	14.	0.60965400	
TREATMENTS	0.10253906	1.	0.10253906	1.7750
RESIDUAL	0.75097656	13.	0.57767425	
TOTAL	0.20058594	27.		

PROB. OF F = 0.20564

ONE WAY ANOVA WITH REPEATED MEASURES (BACK SKATING 60 FEET)

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN PEOPLE	0.35275879	13.	0.27135289	
WITHIN PEOPLE	0.12585449	14.	0.89896023	
TREATMENTS	0.69580078	1.	0.69580078	0.7608
RESIDUAL	0.11889648	13.	0.91458797	
TOTAL	0.47861328	27.		

PROB. OF F = 0.39890

ONE WAY ANOVA WITH REPEATED MEASURES (BACK SKATING 90 FEET)

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN PEOPLE	0.95024414	13.	0.73095703	
WITHIN PEOPLE	0.19038086	14.	0.13598633	
TREATMENTS	0.48876953	1.	0.48876953	4.4903
RESIDUAL	0.14150391	13.	0.10884911	
TOTAL	0.11406250	27.		

PROB. OF F = 0.05391

ONE WAY ANOVA WITH REPEATED MEASURES (BACK SKATING 120 FEET)

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN PEOPLE	0.15031250	13.	0.11562500	
WITHIN PEOPLE	0.41445312	14.	0.29603791	
TREATMENTS	0.76171875	1.	0.76171875	2.9273
RESIDUAL	0.33828125	13.	0.26021630	
TOTAL	0.19175781	27.		

PROB. OF F = 0.11083

ONE WAY ANOVA WITH REPEATED MEASURES (AGILITY)

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN PEOPLE	0.12722656	13.	0.97866583	
WITHIN PEOPLE	0.10363281	14.	0.74023438	
TREATMENTS	0.66171875	1.	0.66171875	22.9635
RESIDUAL	0.37460937	13.	0.28816104	
TOTAL	0.23085937	27.		

PROB. OF F = 0.00035

ONE WAY ANOVA WITH REPEATED MEASURES (PUCK CONTROL)

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN PEOPLE	0.28390625	13.	0.21838942	
WITHIN PEOPLE	0.20246094	14.	0.14461489	
TREATMENTS	0.49140625	1.	0.49140625	4.1666
RESIDUAL	0.15332031	13.	0.11793861	
TOTAL	0.48636719	27.		

PROB. OF F = 0.06207

APPENDIX E

Raw scores for all subjects on every item

CONTROL GROUP

PHYSICAL WORK CAPACITY

SUBJECTS	NO	PWC_{170}		$PWC_{170/Kg/body Wt.}$	
		PRE	POST	PRE	POST
BELLOW J.	1	389	381	13.05	12.34
BETTCHER D.	2	406	416	13.34	13.17
CHABUN A.	3	311	344	7.59	8.22
COLVIN T.	4	288	319	13.47	15.11
DEVLIN J.	5	387	394	13.62	13.48
GYNANE S.	6	464	465	14.59	14.31
HALLS G.	7	357	356	15.69	15.23
McLEOD S.	8	395	412	14.84	15.51
McPHERSON K.	9	335	361	11.65	12.45
MISSOURI D.	10	419	405	17.38	16.39
MITTAL P.	11	399	396	16.87	17.16
OOSTERHUIS E.	12	490	507	16.70	17.16
SZASZKIEWICZ P.	13	529	529	18.01	17.79
WOZNEY D.	14	347	441	9.65	11.77
MEANS		394	409	14.03	14.29
S.D.		64.58	57.85	2.85	2.51

ANTHROPOMETRIC MEASURES OF CONTROL GROUP

NO	AGE (MONTHS) PRE	POST	HEIGHT (INCHES) PRE	POST	WEIGHT (POUNDS) PRE	POST	BI-ILIAC (CM) PRE	POST	BI-ACROMIAL (CM) PRE	POST
1	100.5	104.5	54.25	55.50	65.5	68.0	19.7	20.0	26.9	28.9
2	99.0	103.0	53.00	53.25	67.0	69.5	20.2	20.5	27.3	28.8
3	96.0	100.0	53.50	54.25	90.0	92.0	22.5	22.4	28.5	30.2
4	98.5	102.5	48.25	48.75	47.0	46.5	17.3	17.7	26.3	26.5
5	102.5	106.5	54.50	54.75	62.5	64.4	22.4	23.2	27.2	28.6
6	104.0	108.0	55.00	55.25	70.0	71.4	21.0	21.2	28.7	28.9
7	95.0	99.0	47.50	48.50	50.0	51.5	20.0	19.1	28.2	28.4
8	98.0	102.0	51.75	51.25	58.5	58.4	20.1	20.2	27.5	28.0
9	101.5	105.5	52.50	53.00	63.3	63.8	20.3	20.6	26.3	29.0
10	98.0	102.0	49.75	49.25	53.0	54.4	20.0	20.3	25.3	26.3
11	102.5	106.5	49.75	49.50	52.0	50.8	18.5	18.9	25.6	27.8
12	99.0	103.0	51.00	51.50	64.5	65.0	20.0	20.3	29.0	28.0
13	97.0	101.0	49.50	49.00	64.2	65.4	19.5	19.7	26.9	27.4
14	101.5	105.5	53.00	53.00	79.0	82.4	21.4	21.9	28.3	29.1
MEANS	99.5	103.5	51.66	51.91	63.3	64.5	20.2	20.4	27.3	28.3
S.D.	2.6	2.6	2.3	2.5	11.1	11.9	1.3	1.4	1.1	1.0

CONTROL GROUP

FITNESS PERFORMANCE ITEMS

NO	50 YARD (SEC)		300 YARD (SEC)		SHUTTLE RUN (SEC)		FLEX. ARM H. (SEC)		STAND. LONG JUMP (IN.)		1 MIN. SPEED SIT-UPS	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
1	10.3	9.4	78.0	71.7	15.0	15.1	14	19	53.25	58.25	21	27
2	8.5	9.1	70.0	73.0	12.6	12.4	17	10	59.75	51.75	38	32
3	9.8	9.4	79.6	76.8	12.5	12.4	05	01	47.75	37.25	04	07
4	10.2	9.5	79.0	74.5	14.0	13.2	37	11	39.75	42.25	06	19
5	9.8	9.5	78.5	72.0	14.1	13.6	17	27	54.25	55.75	15	19
6	9.0	8.8	73.4	68.6	14.4	12.7	15	21	55.75	56.00	26	27
7	8.4	8.4	68.5	65.8	12.6	11.5	16	29	59.00	48.50	28	22
8	8.9	8.7	70.4	73.1	11.6	11.8	48	28	56.75	58.00	32	37
9	9.7	9.3	75.4	73.8	14.2	13.6	07	20	49.00	50.00	15	18
10	9.3	9.2	71.0	73.8	12.7	13.0	25	19	46.50	44.25	32	17
11	9.1	8.8	71.5	69.4	12.2	11.6	21	12	53.75	48.00	24	26
12	9.3	8.5	69.9	69.7	13.4	12.8	09	11	51.50	51.50	22	35
13	8.9	8.7	71.6	76.1	14.6	11.7	11	15	53.25	52.75	09	20
14	9.2	9.2	74.0	72.0	14.0	13.6	29	16	51.75	52.75	06	28
MEANS	9.3	9.0	73.6	72.1	13.4	12.8	19.4	17.0	52.29	50.50	19.9	23.9
S.D.	0.5	0.4	3.7	2.8	1.0	0.9	11.5	7.6	5.09	5.85	10.5	7.7

STRENGTH CONTROL GROUP

NO	GRIP LEFT		GRIP RIGHT		ARM EXT.		ARM FLEX.		KNEE EXT.	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
1	38.5	41.8	40.7	48.4	16.3	12.5	22.6	20.9	27.6	36.4
2	41.8	45.1	33.0	37.4	20.1	19.7	25.1	22.1	46.5	43.6
3	41.8	45.1	40.7	46.2	22.6	26.9	21.4	17.3	52.8	46.0
4	19.8	24.2	26.4	25.3	8.8	10.1	11.3	14.9	20.1	26.9
5	31.9	34.1	39.6	40.7	13.8	16.1	27.6	26.9	42.7	34.1
6	39.6	38.5	39.6	40.7	12.6	16.1	13.8	11.3	49.0	44.8
7	33.0	33.0	37.4	36.3	11.3	10.1	13.8	10.1	37.7	36.4
8	31.9	36.0	35.2	34.1	12.6	19.7	18.8	18.5	40.2	47.2
9	42.9	46.2	49.5	49.5	15.1	11.3	18.8	14.9	25.1	32.9
10	38.5	36.3	39.6	33.0	8.8	12.5	16.3	16.1	49.0	43.6
11	24.2	33.0	25.3	39.6	10.0	10.1	16.3	14.9	37.7	43.6
12	39.6	44.0	38.5	37.4	12.6	12.5	16.3	22.1	35.2	48.4
13	41.8	48.4	40.7	47.3	17.6	29.3	28.9	34.1	32.7	43.6
14	40.7	42.9	46.2	39.6	13.8	19.7	20.1	19.7	47.7	54.4
MEANS	36.1	39.2	38.0	39.7	14.0	16.2	19.3	18.8	38.9	41.6
S.D.	6.8	6.5	6.3	6.4	3.9	5.9	5.1	6.1	9.5	7.0

N.B. All measures in pounds.

HOCKEY GROUP

PHYSICAL WORK CAPACITY

SUBJECTS	NO	PWC_{170}		PWC_{170}/Kg/Body Wt.	
		PRE	POST	PRE	POST
ANTONIUK M.	15	512	563	15.23	15.97
CARLSON R.	16	393	449	15.15	16.73
DONADT R.	17	356	452	13.64	16.29
DONALD S.	18	420	437	12.84	12.81
HOLGATE B.	19	398	471	16.07	18.18
JONES B.	20	327	332	12.10	11.87
LEISEN B.	21	382	412	11.74	12.25
LUND G.	22	424	510	17.12	19.88
LUND T.	23	407	459	17.24	18.87
MACNAB B.	24	392	441	15.98	16.72
MILLIGAN P.	25	365	365	13.37	13.60
ROBERGE D.	26	395	373	15.81	14.38
TKACHUK S.	27	357	380	14.26	14.42
WOZNIAK L.	28	351	414	12.97	14.82
MEANS		391.36	432.71	14.54	15.49
S.D.		42.87	58.36	1.73	2.37

ANTHROPOMETRIC MEASURES OF HOCKEY GROUP

NO	AGE (MONTHS)		HEIGHT (INCHES)		WEIGHT (POUNDS)		BI-ILIAC (CM)		BI-ACROMIAL (CM)	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
15	106.5	110.5	56.00	56.00	74.0	77.5	21.7	21.7	29.4	29.5
16	101.5	105.5	51.75	52.50	57.0	59.0	19.3	20.1	28.4	28.3
17	104.0	108.0	52.50	53.00	57.5	61.0	19.4	19.4	28.2	28.3
18	102.0	106.0	54.75	55.25	72.0	75.0	21.6	21.7	29.7	30.5
19	95.5	99.5	52.75	52.75	54.5	57.0	20.1	20.6	27.4	28.1
20	99.0	103.0	52.00	52.75	59.5	61.5	19.2	19.0	28.5	28.8
21	100.5	104.5	55.00	56.25	71.5	74.0	21.9	22.1	27.6	28.0
22	100.5	104.5	51.00	51.50	54.5	56.4	22.0	20.5	28.0	28.9
23	100.5	104.5	50.50	51.00	52.0	53.5	19.9	20.1	27.9	28.1
24	100.5	104.5	51.25	52.25	54.0	58.0	20.0	20.4	27.2	28.7
25	103.0	107.0	51.75	51.75	60.0	59.0	19.0	19.5	27.3	28.0
26	105.5	109.5	49.50	50.50	55.0	57.0	21.1	20.1	28.0	27.9
27	105.0	109.0	49.75	50.50	55.0	58.0	19.5	19.8	26.8	26.9
28	99.0	103.0	52.25	52.75	59.5	61.5	20.0	20.0	28.9	29.5
MEANS	101.6	105.6	52.19	52.77	59.7	62.0	20.3	20.4	28.1	28.5
S.D.	2.8	2.8	1.85	1.79	7.0	7.3	1.0	0.8	0.8	0.8

HOCKEY GROUP

FITNESS PERFORMANCE ITEMS

NO	50 YARD (SEC)		300 YARD (SEC)		SHUTTLE RUN (SEC)		FLEX. ARM H. (SEC)		STAND. LONG JUMP (IN.)		1 MIN SPEED SIT-UPS	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
15	9.2	9.0	67.4	65.5	12.9	12.2	45	63	57.25	58.15	36	26
16	9.0	8.6	66.5	65.5	12.3	11.9	74	60	57.30	59.50	30	29
17	8.6	8.5	67.7	65.5	12.2	11.4	45	61	57.75	52.25	35	36
18	9.1	8.4	68.7	66.0	12.9	11.5	40	64	61.25	56.60	28	17
19	8.9	8.8	70.9	66.4	14.5	12.4	37	80	60.00	56.15	31	22
20	8.7	8.5	68.5	70.0	13.0	12.4	21	25	56.00	49.75	34	26
21	8.9	8.8	73.6	71.5	12.6	11.6	17	33	51.25	58.00	32	29
22	8.9	8.9	72.0	71.5	13.2	11.8	35	74	52.75	60.00	37	35
23	9.4	9.0	71.3	71.0	12.6	11.2	72	68	57.75	60.25	37	39
24	9.1	8.8	70.0	66.0	13.1	12.8	61	72	52.25	54.00	40	39
25	9.0	10.5	71.8	73.0	13.0	11.8	22	13	51.00	48.50	22	10
26	8.2	8.3	63.2	65.4	12.2	11.4	50	60	62.00	62.80	42	42
27	9.6	8.9	81.4	74.0	15.0	11.6	20	75	56.25	53.75	28	31
28	9.2	8.9	72.8	67.5	13.1	11.2	15	60	51.75	50.15	33	40
MEANS	9.0	8.9	70.4	68.5	13.0	11.8	39.6	57.7	56.04	55.70	33.2	30.0
S.D.	0.3	0.5	4.1	3.0	0.8	0.5	18.9	19.1	3.57	4.25	5.1	9.0

STRENGTH HOCKEY GROUP

NO	GRIP LEFT		GRIP RIGHT		ARM EXT.		ARM FLEX.		KNEE EXT.	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
15	55.0	60.5	58.3	60.5	11.3	26.9	22.6	19.7	59.1	49.6
16	41.8	44.0	39.6	40.7	11.3	12.5	16.3	17.3	47.7	53.2
17	40.7	45.1	41.8	48.4	11.3	17.3	18.8	19.7	47.7	56.8
18	48.4	58.3	55.0	51.7	18.8	22.1	30.2	26.9	55.3	46.0
19	33.0	45.1	33.0	44.0	8.8	11.3	13.8	19.7	28.9	29.3
20	39.6	37.4	35.2	36.3	8.8	12.5	25.1	24.5	40.2	43.6
21	39.6	39.6	38.5	38.5	12.6	14.9	17.6	19.7	49.0	50.8
22	34.1	35.2	36.3	36.3	12.6	14.9	15.1	19.7	32.7	34.1
23	29.7	35.2	38.5	40.7	11.3	13.7	15.1	14.9	32.7	24.5
24	37.4	38.5	35.2	38.5	11.3	12.5	13.8	18.5	27.6	30.5
25	41.8	45.1	39.6	40.7	10.1	14.9	17.6	14.9	37.7	36.4
26	37.4	42.9	38.5	41.8	18.8	24.5	20.1	29.3	52.8	53.2
27	33.0	37.4	30.8	37.4	20.1	23.3	17.6	19.7	41.5	43.6
28	39.6	41.8	40.7	45.1	7.5	14.9	18.8	20.9	35.2	43.6
MEANS	39.4	43.3	40.0	42.9	12.5	16.9	18.8	20.4	42.0	42.5
S.D.	6.2	7.4	7.3	6.5	3.8	4.9	4.4	3.9	9.7	9.7

N.B. All measures in pounds.

HOCKEY SKILL ITEMS

NO		FRONT SKATING 60'	90'	120'	BACK SKATING 60'	90'	120'	AGILITY	PUCK CONTROL
15	PRE	3.5	5.0	6.5	4.8	6.8	9.1	13.7	17.4
	POST	3.7	5.1	6.6	5.0	6.9	9.0	13.2	20.6
16	PRE	3.6	5.1	6.8	5.1	8.0	10.4	12.8	20.2
	POST	4.0	5.3	7.0	5.6	7.3	10.4	12.7	18.4
17	PRE	3.6	5.2	6.5	5.2	7.5	9.8	13.2	18.4
	POST	3.4	5.0	6.5	5.2	7.6	10.2	13.0	18.5
18	PRE	3.5	4.9	6.4	5.8	8.2	10.6	13.6	21.6
	POST	3.2	4.5	6.3	5.5	7.6	10.3	13.5	20.1
19	PRE	3.6	5.2	7.0	6.0	8.6	12.2	15.9	21.8
	POST	3.5	5.0	6.7	5.8	7.4	10.9	13.9	19.3
20	PRE	3.7	5.5	7.0	6.0	8.8	11.4	14.5	20.7
	POST	3.5	4.7	6.6	6.0	8.7	11.3	12.8	18.9
21	PRE	3.3	5.0	6.5	5.8	7.9	10.8	12.5	17.9
	POST	3.9	5.3	6.8	5.2	7.2	9.5	11.5	17.7
22	PRE	3.5	4.8	6.5	5.0	7.1	9.4	13.6	17.7
	POST	3.5	4.6	6.1	5.2	7.1	9.6	12.5	17.1
23	PRE	3.7	5.0	6.7	4.9	7.0	9.0	12.7	18.4
	POST	3.7	4.9	6.8	5.3	7.4	10.0	12.8	18.7
24	PRE	3.6	5.1	6.8	5.9	8.4	10.9	14.0	19.6
	POST	4.0	5.4	6.9	6.0	8.4	11.2	12.7	17.0
25	PRE	3.7	5.1	6.6	6.4	8.7	11.9	14.9	20.5
	POST	4.0	5.4	6.9	5.5	9.1	10.8	12.7	19.5
26	PRE	3.2	4.6	6.6	5.2	8.2	10.3	13.1	18.5
	POST	3.2	4.7	6.4	5.4	7.6	10.1	11.7	18.9
27	PRE	3.8	5.4	6.6	6.0	8.4	11.0	13.6	20.0
	POST	3.4	4.9	6.0	5.2	8.0	9.8	12.0	18.0
28	PRE	3.5	4.9	6.9	5.3	7.6	10.3	13.3	18.6
	POST	3.4	4.9	6.1	5.1	7.2	9.4	12.8	16.9
MEANS	PRE	3.6	5.0	6.7	5.5	7.9	10.5	13.7	19.4
	POST	3.6	5.0	6.5	5.4	7.7	10.2	12.7	18.5
S.D.	PRE	0.1	0.2	0.2	0.5	0.6	0.9	0.9	1.4
	POST	0.2	0.2	0.3	0.3	0.6	0.6	0.6	1.1

N.B. All scores in seconds.